

Appl. No. 10/074,941

Response to Office Action dated July 21, 2004

LISTING OF THE CLAIMS

Claims 1-56 are pending. No claims are amended, added, or canceled.

The following listing of claims replaces all prior versions and listings of claims in the application.

1. (Original) A method for image retrieval using a statistical bigram correlation model, the method comprising:

receiving a plurality of images responsive to multiple search sessions;

determining whether the images are semantically relevant images via relevance feedback; and

estimating a respective semantic correlation between each of at least one pair of the images with a respective bigram frequency, each respective bigram frequency being based on multiple search sessions in which each image of the pair is indicated to be a semantically relevant image.

2. (Original) A method as recited in claim 1, further comprising:

assigning a respective ranking score to each of the images based at least in part on the respective semantic correlation corresponding to the image; and

displaying only those images with a highest range of ranking scores.

3. (Original) A method as recited in claim 1, further comprising, responsive to a search session, dynamically updating the respective bigram frequency corresponding to two of the images.

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1 4. (Original) A method as recited in claim 1, wherein the respective semantic
2 correlation is: (a) a positive correlation between two semantically relevant images;
3 (b) a negative correlation between a semantically relevant image and a
4 semantically irrelevant image; and (c) no correlation otherwise.

5 6. 5. (Original) A method as recited in claim 1:

7 wherein the respective semantic correlation is performed offline or online
8 to calculate unigram and bigram frequencies from relevance feedback information,
9 the unigram frequency being based on relevance feedback to a session of the
10 multiple search sessions, the unigram frequency indicating that each respective
11 image of the images is either semantically relevant to the session, semantically
12 less relevant to the session, or a non-feedback image with respect to the session;
13 and

14 wherein each respective bigram frequency is based on a pair of unigram
15 frequencies.

16 17 6. (Original) A method as recited in claim 1, wherein estimating the respective
18 semantic correlation further comprises:

19 associating a respective unigram frequency with each of the images, the
20 unigram frequency indicating that each respective image of the images is either
21 semantically relevant, semantically less relevant, or a non-feedback image, the
22 unigram frequency being based on relevance feedback to a session of the multiple
23 search sessions; and

24 wherein each respective bigram frequency is based on a pair of unigram
25 frequencies.

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1
2 7. (Original) A method as recited in claim 1, wherein estimating the respective
3 semantic correlation further comprises:

4 associating a respective unigram frequency with each of the images, the
5 unigram frequency indicating that each respective image of the images is either
6 semantically relevant, semantically less relevant, or a non-feedback image, the
7 unigram frequency being based on relevance feedback to a session of the multiple
8 search sessions;

9 determining a maximum frequency from a maximum value of the bigram
10 and unigram frequencies; and

11 wherein the respective semantic correlation is further based on the
12 maximum frequency.

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14 8. (Original) A method as recited in claim 1, further comprising identifying, for
15 each image obtained responsive to one or more search sessions of the multiple
16 search sessions, a respective semantic support based on a similarity measure
17 and/or the respective semantic correlation, the similarity measure corresponding to
18 a similarity of a respective feature vector of the image and a search query
19 corresponding to the session.

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21 9. (Original) A method as recited in claim 1, further comprising:

22 identifying, for each image obtained responsive to one or more search
23 sessions of the multiple search sessions, a respective semantic support based on a
24 similarity measure and/or the respective semantic correlation, the similarity

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1 measure corresponding to a similarity of a respective feature vector of the image
2 and a search query corresponding to the session;

3 assigning a respective ranking score to each of the images based upon the
4 respective similarity measure, the respective semantic support, and a semantic
5 weight; and

6 displaying only those images with a highest range of respective ranking
7 scores.

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9 10. (Original) A method as recited in claim 1, wherein estimating the
10 respective semantic correlation is determined as follows:

- 11 • $0 \leq R(I, J) \leq 1$ [if is true in all cases]
- 12 • $R(I, J) = R(J, I)$; [if is true in all cases]
- 13 • if $I = J$ and $U(I) \leq 0$: $R(I, J) = 0$;
- 14 • if $I \neq J$ and $B(I, J) \leq 0$: $R(I, J) = 0$;
- 15 • if $I = J$ and $U(I) > 0$: $R(I, J) = U(I)/T$; or
- 16 • if $I \neq J$ and $B(I, J) > 0$: $R(I, J) = B(J)/T$;

17 wherein I, J are two images, $B(I, J)$ is their bigram frequency, $U(I)$ is the
18 unigram frequency of image I , T is the maximum frequency, $R(I, J)$ is the
19 correlation between image I and J.

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21 11. (Original) A method as recited in claim 1, wherein each respective bigram
22 frequency is based on a pair of unigram frequencies, and wherein the method
23 further comprises performing the respective semantic correlation offline by:

- 24 (a) initializing all unigram and bigram frequencies to zero;
- 25 (b) clustering search sessions with a same query into groups;

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- 1 (c) calculating unigram counts within a group;
- 2 (d) updating unigram frequencies ;
- 3 (e) updating bigram frequencies;
- 4 (f) repeating operations (c), (d), and (f) for all session groups;
- 5 (g) setting all negative unigram and bigram frequencies to zero; and
- 6 (h) calculating each respective semantic correlation based on results of (a)
- 7 through (f).

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9 12. (Original) A method as recited in claim 1, wherein each respective bigram
10 frequency is based on a pair of unigram frequencies, wherein $C(I)$ is a unigram
11 count of image I , and wherein the method further comprises performing the
12 respective semantic correlation offline by:

- 13 (a) initializing $C(I)$ to zero (0);
14 (b) iteratively updating $C(I)$ for every session in a group such that:

15 $C(I) = C(I) + 1$, if image I is labeled as relevant in a session;

16 $C(I) = C(I) - 1$, if image I is labeled as irrelevant in a session;

17 and

19 $C(I)$ is unchanged otherwise.

- 20 (c) repeating (b) for every image of the images;
21 (d) updating each respective unigram frequencies as $U(I) = U(I) + C(I)$;
22 (e) updating each respective bigram frequency of an image pair such
23 that:

25 $B(I, J) = B(I, J) + \min\{C(I), C(J)\}$, if $C(I) > 0, C(J) > 0$,

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1 $B(I,J) = B(I,J) - \min\{C(I), -C(J)\}$, if $C(I) > 0, C(J) < 0$,

2 $B(I,J) = B(I,J) - \min\{-C(I), C(J)\}$, if $C(I) < 0, C(J) > 0$, and

3 $B(I,J) = B(I,J)$, otherwise; and

4 wherein I, J are two images, $B(I,J)$ is their bigram frequency, and
5 $U(I)$ is the unigram frequency of image I .

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8 13. (Original) A method as recited in claim 1, wherein each respective bigram
9 frequency is based on a pair of unigram frequencies, and wherein the method
10 further comprises performing the respective semantic correlation online by:

11 (a) calculating unigram counts in a particular search session;

12 (b) updating unigram frequencies;

13 (c) updating bigram frequencies; and

14 (d) updating each respective semantic correlation between each of the
15 images based on results of (a) through (c).

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1 14. (Original) A method as recited in claim 1, wherein each respective bigram
2 frequency is based on a pair of unigram frequencies, wherein $C(I)$ is a unigram
3 count of image I , wherein $U(I)$ is a unigram frequency of image I , wherein
4 $B(I,J)$ is a bigram frequency of image I and J , wherein a session group comprises
5 a single search session, and wherein the method further comprises performing the
6 respective semantic correlation online by:

7 (a) responsive to determining that there is a user log, updating
8 calculating each respective unigram and bigram frequency according to data in
9 the user log;

10 (b) responsive to determining that there is not a user log, initializing
11 each $C(I)$ and $B(I)$ to zero (0);

12 (c) iteratively updating $C(I)$ for the single search session such that:

13 $C(I) = 1$, if image I is labeled as relevant;

14 $C(I) = -1$, if image I is labeled as irrelevant; and

15 $C(I) = 0$, if $C(I)$ is a non-feedback image;

16 (d) updating each respective unigram frequencies as $U(I) = U(I) + C(I)$;

17 (e) updating each respective bigram frequency of an image pair such
18 that:

19 $B(I,J) = B(I,J) + 1$, if $C(I) > 0, C(J) > 0$,

20 $B(I,J) = B(I,J) - 1$, if $C(I) > 0, C(J) < 0$,

21 $B(I,J) = B(I,J) - 1$, if $C(I) < 0, C(J) > 0$, or

22 $B(I,J) = B(I,J)$, otherwise; and

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1 wherein I, J are two images, and $B(I, J)$ is their bigram frequency.

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3 15. (Original) A computer-readable medium for image retrieval using a
4 statistical bigram correlation model, the computer-readable medium comprising
5 computer-executable instructions for:

6 receiving a plurality of images responsive to multiple search sessions;
7 determining whether the images are semantically relevant images via
8 relevance feedback; and

9 estimating a respective semantic correlation between each of at least one
10 pair of the images with a respective bigram frequency, each respective bigram
11 frequency representing a probability of whether two of the images are
12 semantically related to one-another based on a co-occurrence frequency that each
13 image of the two images was relevant in a previous query/feedback session.

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15 16. (Original) A computer-readable medium as recited in claim 15, further
16 comprising instructions for:

17 assigning a respective ranking score to each of the images based at least in
18 part on the respective semantic correlation corresponding to the image; and
19 displaying only those images with a highest range of ranking scores.

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21 17. (Original) A computer-readable medium as recited in claim 15, further
22 comprising instructions for, responsive to a search session, dynamically updating
23 the respective bigram frequency corresponding to two of the images.

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1 18. (Original) A computer-readable medium as recited in claim 15, wherein the
2 respective semantic correlation is: (a) a positive correlation between two
3 semantically relevant images; (b) a negative correlation between a semantically
4 relevant image and a semantically irrelevant image; and (c) no correlation
5 otherwise.

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7 19. (Original) A computer-readable medium as recited in claim 15:

8 wherein the respective semantic correlation is performed offline or online
9 to calculate unigram and bigram frequencies from relevance feedback information,
10 the unigram frequency being based on relevance feedback to a session of the
11 multiple search sessions, the unigram frequency indicating that each respective
12 image of the images is either semantically relevant to the session, semantically
13 less relevant to the session, or a non-feedback image with respect to the session;
14 and

15 wherein each respective bigram frequency is based on a pair of unigram
16 frequencies.

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18 20. (Original) A computer-readable medium as recited in claim 15, wherein
19 estimating the respective semantic correlation further comprises instructions for:

20 associating a respective unigram frequency with each of the images, the
21 unigram frequency indicating that each respective image of the images is either
22 semantically relevant, semantically less relevant, or a non-feedback image, the
23 unigram frequency being based on relevance feedback to a session of the multiple
24 search sessions; and

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1 wherein each respective bigram frequency is based on a pair of unigram
2 frequencies.

3
4 21. (Original) A computer-readable medium as recited in claim 15, wherein
5 estimating the respective semantic correlation further comprises instructions for:

6 associating a respective unigram frequency with each of the images, the
7 unigram frequency indicating that each respective image of the images is either
8 semantically relevant, semantically less relevant, or a non-feedback image, the
9 unigram frequency being based on relevance feedback to a session of the multiple
10 search sessions;

11 determining a maximum frequency from a maximum value of the bigram
12 and unigram frequencies; and

13 wherein the respective semantic correlation is further based on the
14 maximum frequency.

15
16 22. (Original) A computer-readable medium as recited in claim 15, further
17 comprising instructions for identifying, for each image obtained responsive to one
18 or more search sessions of the multiple search sessions, a respective semantic
19 support based on a similarity measure and/or the respective semantic correlation,
20 the similarity measure corresponding to a similarity of a respective feature vector
21 of the image and a search query corresponding to the session.

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1 23. (Original) A computer-readable medium as recited in claim 15, further
2 comprising instructions for:

3 identifying, for each image obtained responsive to one or more search
4 sessions of the multiple search sessions, a respective semantic support based on a
5 similarity measure and/or the respective semantic correlation, the similarity
6 measure corresponding to a similarity of a respective feature vector of the image
7 and a search query corresponding to the session;

8 assigning a respective ranking score to each of the images based upon the
9 respective similarity measure, the respective semantic support, and a semantic
10 weight; and

11 displaying only those images with a highest range of respective ranking
12 scores.

13
14 24. (Original) A computer-readable medium as recited in claim 15, wherein
15 estimating the respective semantic correlation is determined as follows:

- 16 • $0 \leq R(I, J) \leq 1$
- 17 • $R(I, J) = R(J, I)$;
- 18 • if $I = J$ and $U(I) \leq 0$: $R(I, J) = 0$;
- 19 • if $I \neq J$ and $B(I, J) \leq 0$: $R(I, J) = 0$;
- 20 • if $I = J$ and $U(I) > 0$: $R(I, J) = U(I)/T$; or
- 21 • if $I \neq J$ and $B(I, J) > 0$: $R(I, J) = B(I)/T$;

22 wherein I, J are two images, $B(I, J)$ is their bigram frequency, $U(I)$ is the
23 unigram frequency of image I , T is the maximum frequency, $R(I, J)$ is the
24 correlation between image I and J.

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1 25. (Original) A computer-readable medium as recited in claim 15, wherein
2 each respective bigram frequency is based on a pair of unigram frequencies, and
3 wherein the computer-executable instructions further comprise instructions for
4 performing the respective semantic correlation offline by:

- 5 (a) initializing all unigram and bigram frequencies to zero;
- 6 (b) clustering search sessions with a same query into groups;
- 7 (c) calculating unigram counts within a group;
- 8 (d) updating unigram frequencies ;
- 9 (e) updating bigram frequencies;
- 10 (f) repeating operations (c), (d), and (f) for all session groups;
- 11 (g) setting all negative unigram and bigram frequencies to zero; and
- 12 (h) calculating each respective semantic correlation based on results of (a)

13 through (f).

14
15 26. (Original) A computer-readable medium as recited in claim 15, wherein
16 each respective bigram frequency is based on a pair of unigram frequencies,
17 wherein $C(I)$ is a unigram count of image I , and wherein the computer-executable
18 instructions further comprise instructions for performing the respective semantic
19 correlation offline by:

- 20 (a) initializing $C(I)$ to zero (0);
21 (b) iteratively updating $C(I)$ for every session in a group such that:

22 $C(I) = C(I) + 1$, if image I is labeled as relevant in a session;

23 $C(I) = C(I) - 1$, if image I is labeled as irrelevant in a session;

24 and
25

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1 $C(I)$ is unchanged otherwise;

2 (c) repeating (b) for every image of the images;

3 (d) updating each respective unigram frequencies as $U(I) = U(I) + C(I)$;

4 (e) updating each respective bigram frequency of an image pair such
5 that:

6 $B(I,J) = B(I,J) + \min\{C(I), C(J)\}$, if $C(I) > 0, C(J) > 0$,

7 $B(I,J) = B(I,J) - \min\{C(I), -C(J)\}$, if $C(I) > 0, C(J) < 0$,

8 $B(I,J) = B(I,J) - \min\{-C(I), C(J)\}$, if $C(I) < 0, C(J) > 0$, and

9 $B(I,J) = B(I,J)$, otherwise; and

10 wherein I, J are two images, $B(I,J)$ is their bigram frequency, and
11 $U(I)$ is the unigram frequency of image I .

12 27. (Original) A computer-readable medium as recited in claim 15, wherein
13 each respective bigram frequency is based on a pair of unigram frequencies, and
14 wherein the computer-executable instructions further comprise instructions for
15 performing the respective semantic correlation online by:

16 (a) calculating unigram counts in a particular search session;

17 (b) updating unigram frequencies;

18 (c) updating bigram frequencies; and

19 (d) updating each respective semantic correlation between each of the
20 images based on results of (a) through (c).

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1 28. (Original) A computer-readable medium as recited in claim 15, wherein
2 each respective bigram frequency is based on a pair of unigram frequencies,
3 wherein $C(I)$ is a unigram count of image I , wherein $U(I)$ is a unigram frequency
4 of image I , wherein $B(I,J)$ is a bigram frequency of image I and J , wherein a
5 session group comprises a single search session, and wherein the computer-
6 executable instructions further comprise instructions for performing the respective
7 semantic correlation online by:

8 (a) responsive to determining that there is a user log, updating
9 calculating each respective unigram and bigram frequency according to data in
10 the user log;

11 (b) responsive to determining that there is not a user log, initializing
12 each $C(I)$ and $B(I)$ to zero (0);

13 (c) iteratively updating $C(I)$ for the single search session such that:

14 $C(I) = 1$, if image I is labeled as relevant;

15 $C(I) = -1$, if image I is labeled as irrelevant; and

16 $C(I) = 0$, if $C(I)$ is a non-feedback image;

17 (d) updating each respective unigram frequencies as $U(I) = U(I) + C(I)$;

18 (e) updating each respective bigram frequency of an image pair such
19 that:

20 $B(I,J) = B(I,J) + 1$, if $C(I) > 0, C(J) > 0$,

21 $B(I,J) = B(I,J) - 1$, if $C(I) > 0, C(J) < 0$,

22 $B(I,J) = B(I,J) - 1$, if $C(I) < 0, C(J) > 0$, or

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1 $B(I, J) = B(I, J)$, otherwise; and

2 wherein I, J are two images, and $B(I, J)$ is their bigram frequency.

3

4 **29. (Original) A computing device for image retrieval using a statistical bigram**

5 correlation model, the computing device comprising:

6 a processor; and

7 a memory coupled to the processor, the memory comprising computer-
8 executable instructions that are fetched and executed by the processor for:

9 receiving a plurality of images responsive to multiple search
10 sessions;

11 determining whether the images are semantically relevant images via
12 relevance feedback; and

13 estimating a respective semantic correlation between each of at least
14 one pair of the images with a respective bigram frequency, each respective bigram
15 frequency being based on multiple search sessions in which each image of the pair
16 is indicated to be a semantically relevant image.

17

18 **30. (Original) A computing device as recited in claim 29, further comprising**
19 **instructions for:**

20 assigning a respective ranking score to each of the images based at least in
21 part on the respective semantic correlation corresponding to the image; and

22 displaying only those images with a highest range of ranking scores.

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1 31. (Original) A computing device as recited in claim 29, further comprising
2 instructions for, responsive to a search session, dynamically updating the
3 respective bigram frequency corresponding to two of the images.

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5 32. (Original) A computing device as recited in claim 29, wherein the
6 respective semantic correlation is: (a) a positive correlation between two
7 semantically relevant images; (b) a negative correlation between a semantically
8 relevant image and a semantically irrelevant image; and (c) no correlation
9 otherwise.

10

11 33. (Original) A computing device as recited in claim 29:

12 wherein the respective semantic correlation is performed offline or online
13 to calculate unigram and bigram frequencies from relevance feedback information,
14 the unigram frequency being based on relevance feedback to a session of the
15 multiple search sessions, the unigram frequency indicating that each respective
16 image of the images is either semantically relevant to the session, semantically
17 less relevant to the session, or a non-feedback image with respect to the session;
18 and

19 wherein each respective bigram frequency is based on a pair of unigram
20 frequencies.

21

22 34. (Original) A computing device as recited in claim 29, wherein estimating
23 the respective semantic correlation further comprises instructions for:

24 associating a respective unigram frequency with each of the images, the
25 unigram frequency indicating that each respective image of the images is either

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1 semantically relevant, semantically less relevant, or a non-feedback image, the
2 unigram frequency being based on relevance feedback to a session of the multiple
3 search sessions; and

4 wherein each respective bigram frequency is based on a pair of unigram
5 frequencies.

6
7 35. (Original) A computing device as recited in claim 29, wherein estimating
8 the respective semantic correlation further comprises instructions for:

9 associating a respective unigram frequency with each of the images, the
10 unigram frequency indicating that each respective image of the images is either
11 semantically relevant, semantically less relevant, or a non-feedback image, the
12 unigram frequency being based on relevance feedback to a session of the multiple
13 search sessions;

14 determining a maximum frequency from a maximum value of the bigram
15 and unigram frequencies; and

16 wherein the respective semantic correlation is further based on the
17 maximum frequency.

18
19 36. (Original) A computing device as recited in claim 29, further comprising
20 instructions for identifying, for each image obtained responsive to one or more
21 search sessions of the multiple search sessions, a respective semantic support
22 based on a similarity measure and/or the respective semantic correlation, the
23 similarity measure corresponding to a similarity of a respective feature vector of
24 the image and a search query corresponding to the session.

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1 37. (Original) A computing device as recited in claim 29, further comprising
2 instructions for:

3 identifying, for each image obtained responsive to one or more search
4 sessions of the multiple search sessions, a respective semantic support based on a
5 similarity measure and/or the respective semantic correlation, the similarity
6 measure corresponding to a similarity of a respective feature vector of the image
7 and a search query corresponding to the session;

8 assigning a respective ranking score to each of the images based upon the
9 respective similarity measure, the respective semantic support, and a semantic
10 weight; and

11 displaying only those images with a highest range of respective ranking
12 scores.

13
14 38. (Original) A computing device as recited in claim 29, wherein estimating
15 the respective semantic correlation is determined as follows:

- 16 • $0 \leq R(I, J) \leq 1$
- 17 • $R(I, J) = R(J, I)$;
- 18 • if $I = J$ and $U(I) \leq 0$: $R(I, J) = 0$;
- 19 • if $I \neq J$ and $B(I, J) \leq 0$: $R(I, J) = 0$;
- 20 • if $I = J$ and $U(I) > 0$: $R(I, J) = U(I)/T$; or
- 21 • if $I \neq J$ and $B(I, J) > 0$: $R(I, J) = B(J)/T$;

22 wherein I, J are two images, $B(I, J)$ is their bigram frequency, $U(I)$ is the
23 unigram frequency of image I , T is the maximum frequency, $R(I, J)$ is the
24 correlation between image I and J.

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1 39. (Original) A computing device as recited in claim 29, wherein each
2 respective bigram frequency is based on a pair of unigram frequencies, and
3 wherein the computer-executable instructions further comprise instructions for
4 performing the respective semantic correlation offline by:

5 (a) initializing all unigram and bigram frequencies to zero;
6 (b) clustering search sessions with a same query into groups;
7 (c) calculating unigram counts within a group;
8 (d) updating unigram frequencies ;
9 (e) updating bigram frequencies;
10 (f) repeating operations (c), (d), and (f) for all session groups;
11 (g) setting all negative unigram and bigram frequencies to zero; and
12 (h) calculating each respective semantic correlation based on results of (a)
13 through (f).

14
15 40. (Original) A computing device as recited in claim 29, wherein each
16 respective bigram frequency is based on a pair of unigram frequencies, wherein
17 $C(I)$ is a unigram count of image I , and wherein the computer-executable
18 instructions further comprise instructions for performing the respective semantic
19 correlation offline by:

20 (a) initializing $C(I)$ to zero (0);
21 (b) iteratively updating $C(I)$ for every session in a group such that:

22 $C(I) = C(I) + 1$, if image I is labeled as relevant in a session;

23 $C(I) = C(I) - 1$, if image I is labeled as irrelevant in a session;

24 and
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1 $C(I)$ is unchanged otherwise;

2 (c) repeating (b) for every image of the images;

3 (d) updating each respective unigram frequencies as $U(J) = U(I) + C(I)$;

4 (e) updating each respective bigram frequency of an image pair such

5 that:

6

7 $B(I,J) = B(I,J) + \min\{C(I), C(J)\}$, if $C(I) > 0, C(J) > 0$,

8 $B(I,J) = B(I,J) - \min\{C(I), -C(J)\}$, if $C(I) > 0, C(J) < 0$,

9 $B(I,J) = B(I,J) - \min\{-C(I), C(J)\}$, if $C(I) < 0, C(J) > 0$, and

10 $B(I,J) = B(I,J)$, otherwise; and

11 wherein I, J are two images, $B(I,J)$ is their bigram frequency, and
12 $U(I)$ is the unigram frequency of image I .

13

14

15 41. (Original) A computing device as recited in claim 29, wherein each
16 respective bigram frequency is based on a pair of unigram frequencies, and
17 wherein the computer-executable instructions further comprise instructions for
18 performing the respective semantic correlation online by:

19 (a) calculating unigram counts in a particular search session;

20 (b) updating unigram frequencies;

21 (c) updating bigram frequencies; and

22 (d) updating each respective semantic correlation between each of the
23 images based on results of (a) through (c).

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1 42. (Original) A computing device as recited in claim 29, wherein each
2 respective bigram frequency is based on a pair of unigram frequencies, wherein
3 $C(I)$ is a unigram count of image I , wherein $U(I)$ is a unigram frequency of
4 image I , wherein $B(I, J)$ is a bigram frequency of image I and J , wherein a session
5 group comprises a single search session, and wherein the computer-executable
6 instructions further comprise instructions for performing the respective semantic
7 correlation online by:

8 (a) responsive to determining that there is a user log, updating
9 calculating each respective unigram and bigram frequency according to data in
10 the user log;

11 (b) responsive to determining that there is not a user log, initializing
12 each $C(I)$ and $B(I)$ to zero (0);

13 (c) iteratively updating $C(I)$ for the single search session such that:

14 $C(I) = 1$, if image I is labeled as relevant;

15 $C(I) = -1$, if image I is labeled as irrelevant; and

16 $C(I) = 0$, if $C(I)$ is a non-feedback image;

17 (d) updating each respective unigram frequencies as $U(I) = U(I) + C(I)$;

18 (e) updating each respective bigram frequency of an image pair such
19 that:

20 $B(I, J) = B(I, J) + 1$, if $C(I) > 0, C(J) > 0$,

21 $B(I, J) = B(I, J) - 1$, if $C(I) > 0, C(J) < 0$,

22 $B(I, J) = B(I, J) - 1$, if $C(I) < 0, C(J) > 0$, or

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1 $B(I, J) = B(I, J)$, otherwise; and

2 wherein I, J are two images, and $B(I, J)$ is their bigram frequency.

3

4 **43. (Original)** A computing device image retrieval using a statistical bigram
5 correlation model, the computing device comprising:

6 processing means for:

7 receiving a plurality of images responsive to multiple search
8 sessions;

9 determining whether the images are semantically relevant images via
10 relevance feedback; and

11 estimating a respective semantic correlation between each of at least
12 one pair of the images with a respective bigram frequency, each respective bigram
13 frequency being based on multiple search sessions in which each image of the pair
14 is indicated to be a semantically relevant image.

15

16 **44. (Original)** A computing device as recited in claim 43, further comprising
17 means for:

18 assigning a respective ranking score to each of the images based at least in
19 part on the respective semantic correlation corresponding to the image; and

20 displaying only those images with a highest range of ranking scores.

21

22 **45. (Original)** A computing device as recited in claim 43, further comprising
23 means for, responsive to a search session, dynamically updating the respective
24 bigram frequency corresponding to two of the images.

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46. (Original) A computing device as recited in claim 43, wherein the respective semantic correlation is: (a) a positive correlation between two semantically relevant images; (b) a negative correlation between a semantically relevant image and a semantically irrelevant image; and (c) no correlation otherwise.

47. (Original) A computing device as recited in claim 43:

wherein the respective semantic correlation is performed offline or online to calculate unigram and bigram frequencies from relevance feedback information, the unigram frequency being based on relevance feedback to a session of the multiple search sessions, the unigram frequency indicating that each respective image of the images is either semantically relevant to the session, semantically less relevant to the session, or a non-feedback image with respect to the session; and

wherein each respective bigram frequency is based on a pair of unigram frequencies.

48. (Original) A computing device as recited in claim 43, wherein the processing means for estimating the respective semantic correlation further comprises means for:

associating a respective unigram frequency with each of the images, the unigram frequency indicating that each respective image of the images is either semantically relevant, semantically less relevant, or a non-feedback image, the

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1 unigram frequency being based on relevance feedback to a session of the multiple
2 search sessions; and

3 wherein each respective bigram frequency is based on a pair of unigram
4 frequencies.

5
6 49. (Original) A computing device as recited in claim 43, wherein the
7 processing means for estimating the respective semantic correlation further
8 comprises means for:

9 associating a respective unigram frequency with each of the images, the
10 unigram frequency indicating that each respective image of the images is either
11 semantically relevant, semantically less relevant, or a non-feedback image, the
12 unigram frequency being based on relevance feedback to a session of the multiple
13 search sessions;

14 determining a maximum frequency from a maximum value of the bigram
15 and unigram frequencies; and

16 wherein the respective semantic correlation is further based on the
17 maximum frequency.

18
19 50. (Original) A computing device as recited in claim 43, further comprising
20 processing means for identifying, for each image obtained responsive to one or
21 more search sessions of the multiple search sessions, a respective semantic support
22 based on a similarity measure and/or the respective semantic correlation, the
23 similarity measure corresponding to a similarity of a respective feature vector of
24 the image and a search query corresponding to the session.

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1 51. (Original) A computing device as recited in claim 43, further comprising
2 processing means for:

3 identifying, for each image obtained responsive to one or more search
4 sessions of the multiple search sessions, a respective semantic support based on a
5 similarity measure and/or the respective semantic correlation, the similarity
6 measure corresponding to a similarity of a respective feature vector of the image
7 and a search query corresponding to the session;

8 assigning a respective ranking score to each of the images based upon the
9 respective similarity measure, the respective semantic support, and a semantic
10 weight; and

11 displaying only those images with a highest range of respective ranking
12 scores.

13
14 52. (Original) A computing device as recited in claim 43, wherein the
15 processing means for estimating the respective semantic correlation is determined
16 as follows:

- 17 • $0 \leq R(I, J) \leq 1$;
- 18 • $R(I, J) = R(J, I)$;
- 19 • if $I = J$ and $U(I) \leq 0$: $R(I, J) = 0$;
- 20 • if $I \neq J$ and $B(I, J) \leq 0$: $R(I, J) = 0$;
- 21 • if $I = J$ and $U(I) > 0$: $R(I, J) = U(I)/T$; or
- 22 • if $I \neq J$ and $B(I, J) > 0$: $R(I, J) = B(I)/T$;

23 wherein I, J are two images, $B(I, J)$ is their bigram frequency, $U(I)$ is the
24 unigram frequency of image I , T is the maximum frequency, $R(I, J)$ is the
25 correlation between image I and J.

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1
2 53. (Original) A computing device as recited in claim 43, wherein each
3 respective bigram frequency is based on a pair of unigram frequencies, and
4 wherein the processing means further comprise means for performing the
5 respective semantic correlation offline by:

- 6 (a) initializing all unigram and bigram frequencies to zero;
- 7 (b) clustering search sessions with a same query into groups;
- 8 (c) calculating unigram counts within a group;
- 9 (d) updating unigram frequencies ;
- 10 (e) updating bigram frequencies;
- 11 (f) repeating operations (c), (d), and (f) for all session groups;
- 12 (g) setting all negative unigram and bigram frequencies to zero; and
- 13 (h) calculating each respective semantic correlation based on results of (a)

14 through (f).

15
16 54. (Original) A computing device as recited in claim 43, wherein each
17 respective bigram frequency is based on a pair of unigram frequencies, wherein
18 $C(I)$ is a unigram count of image I , and wherein the processing means further
19 comprise means for performing the respective semantic correlation offline by:

- 20 (a) initializing $C(I)$ to zero (0);
21 (b) iteratively updating $C(I)$ for every session in a group such that:

22 $C(I) = C(I) + 1$, if image I is labeled as relevant in a session;

23 $C(I) = C(I) - 1$, if image I is labeled as irrelevant in a session;

24 and
25

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1 $C(I)$ is unchanged otherwise;

2 (c) repeating (b) for every image of the images;

3 (d) updating each respective unigram frequencies as $U(J) = U(I) + C(I)$;

4 (e) updating each respective bigram frequency of an image pair such

5 that:

6

7 $B(I,J) = B(I,J) + \min\{C(I), C(J)\}$, if $C(I) > 0, C(J) > 0$,

8 $B(I,J) = B(I,J) - \min\{C(I), -C(J)\}$, if $C(I) > 0, C(J) < 0$,

9 $B(I,J) = B(I,J) - \min\{-C(I), C(J)\}$, if $C(I) < 0, C(J) > 0$, and

10 $B(I,J) = B(I,J)$, otherwise; and

11 wherein I, J are two images, $B(I,J)$ is their bigram frequency, and
12 $U(I)$ is the unigram frequency of image I .

13 55. (Original) A computing device as recited in claim 43, wherein each
14 respective bigram frequency is based on a pair of unigram frequencies, and
15 wherein the processing means further comprise means for performing the
16 respective semantic correlation online by:

17 (a) calculating unigram counts in a particular search session;
18 (b) updating unigram frequencies;
19 (c) updating bigram frequencies; and
20 (d) updating each respective semantic correlation between each of the
21 images based on results of (a) through (c).

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1 56. (Original) A computing device as recited in claim 43, wherein each
2 respective bigram frequency is based on a pair of unigram frequencies, wherein
3 $C(I)$ is a unigram count of image I , wherein $U(I)$ is a unigram frequency of
4 image I , wherein $B(I,J)$ is a bigram frequency of image I and J , wherein a session
5 group comprises a single search session, and wherein the processing means further
6 comprise means for performing the respective semantic correlation online by:

7 (a) responsive to determining that there is a user log, updating
8 calculating each respective unigram and bigram frequency according to data in
9 the user log;

10 (b) responsive to determining that there is not a user log, initializing
11 each $C(I)$ and $B(I)$ to zero (0);

12 (c) iteratively updating $C(I)$ for the single search session such that:

13 $C(I) = 1$, if image I is labeled as relevant;

14 $C(I) = -1$, if image I is labeled as irrelevant; and

15 $C(I) = 0$, if $C(I)$ is a non-feedback image;

16 (d) updating each respective unigram frequencies as $U(I) = U(I) + C(I)$;

17 (e) updating each respective bigram frequency of an image pair such
18 that:

19 $B(I,J) = B(I,J) + 1$, if $C(I) > 0, C(J) > 0$,

20 $B(I,J) = B(I,J) - 1$, if $C(I) > 0, C(J) < 0$,

21 $B(I,J) = B(I,J) - 1$, if $C(I) < 0, C(J) > 0$, or

22 $B(I,J) = B(I,J)$, otherwise; and

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1 wherein I, J are two images, and $B(I, J)$ is their bigram frequency.

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